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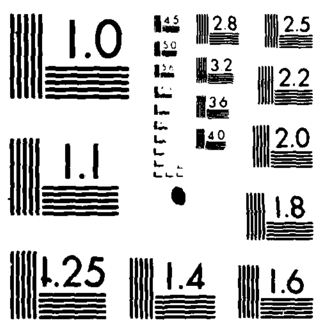

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NAVIGATION TRAINING METHODS FOR LOW-ALTITUDE FLIGHT

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A prototype training course to apply map interpretation and terrain analysis (MITAC-II) to low-altitude fixed-wing navigation was developed to improve visual orientation skills of Marine Corps aircrews. The course consisted of a slide-tape illustrated lecture and a series of dynamic simulation exercises using 70-mm cinematic techniques. Fifteen advanced aircrew training instructors participated in the demonstration and evaluation of the course and served as subject-matter experts. MITAC-II was pronounced effective in improving low-altitude orientation with specific improvements recommended for the production model.

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FOREWORD

This research and development was conducted under contract N00123-79-C-1461 with the Boeing Military Airplane Company in support of exploratory development task area ZF63.521.080 (USMC Manpower and Training Technology) and was sponsored by Headquarters, Marine Corps (Code APW). It is concerned with efforts to apply map interpretation and terrain analysis methods in support of visual geographic orientation training for Navy and Marine Corps aircrews involved in low-altitude operations.

Appreciation is expressed to the aircrews of Marine Aviation Weapons and Tactics Squadron-One (MAWTS-1), Marine Corps Air Station, Yuma, Arizona and Fighter Squadron (FITRON) 124, Naval Air Station, Miramar, San Diego, California for their participation in the feasibility demonstration. Special appreciation is expressed to Major J. D. Wojtasek, MAWTS-1, and LCDR J. Dodge, FITRON 124, for their efforts in coordinating the aircrews and providing operational recommendations to the course.

The contracting officer's technical representative was Orvin A. Larson. The recommendations herein are directed to Headquarters, Marine Corps.

JAMES F. KELLY, JR.
Commanding Officer

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Technical Director

SUMMARY

Problem

High-speed, low-altitude flight in fixed-wing aircraft presents unique problems in accurate navigation and orientation. These problems include the extreme dynamic geometry of the landscape and the restricted geographic frame-of-reference not encountered at medium and higher altitudes.

Objective

The objective of this study was to apply map interpretation and terrain analysis methods to the low-altitude geographic orientation problem.

Approach

A map interpretation and terrain analysis course (MITAC-II) was developed to improve visual orientation skills of Marine Corps aircrews through a tape-and-dual-slide lecture format. The lecture was complemented by dynamic low-altitude orientation exercises that allowed participants to practice lessons given in the tape-and-dual-slide lecture. The prototype training course was evaluated by aircrew instructors from the Marine Corps Air Station, Yuma, Arizona and Naval Air Station, Miramar, San Diego, California.

Findings

Participants indicated that MITAC-II was a valuable training tool and that it increased their awareness of topography and contributed significantly to their ability to convert their map into a three-dimensional terrain picture. The content and objectives of the course were compatible with the requirements and past experiences of these qualified aviators. The dynamic exercises were reported to be an effective method of training and the wide-angle screen was extremely effective in achieving realistic visual orientation.

Conclusion

Use of MITAC-II as a training concept and approach to low-altitude orientation is progressive and advantageous. The exercises, using the wide-angle visual system, are effective in integrating the training content with operational tasks.

Recommendations

1. Improvements are possible in some areas, including refining lecture graphics, offering a wider diversity of terrain type, emphasizing balance within the lecture modules, and improving performance cues and response measures.

2. The event switch that causes the film frame number and plotting mark points to be recorded at each response on the map should be refined for simplified training delivery.

3. The event-switch data could be improved by providing participants with additional response-procedure instructions and familiarization.

4. The mark point plotting technique used with the corridor exercises could be improved by use of a multiple-choice response set on the map.

5. MITAC-II should be evaluated for training effectiveness using aircrew personnel from an operational squadron.

6. The illustrated lecture portion of MITAC-II should be evaluated to determine its training effectiveness as a "stand alone" product.

7. Alternate visual media configurations should be evaluated to determine the most effective training delivery system.

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INTRODUCTION

Problem

Geographic orientation in air operations imposes unique and severe problems for the aircrews and systems. The restricted geographic frame of reference and extreme dynamic geometry of the landscape encountered at minimum terrain clearance altitudes in a tactical combat environment, make accurate navigation more difficult than at medium and higher altitudes. The limitations or even absence of traditional navigation aids at low altitudes lead to increased crew workload, and the introduction of small navigation errors can disorient the pilot and lower the probability of successful mission accomplishment. A need exists, therefore, to explore techniques that enable the aircrew to achieve precise low-altitude orientation consistent with current and anticipated mission requirements.

Objective

The objective of this research was to demonstrate the feasibility of using map interpretation and terrain analysis methods to instruct aircrews in low-altitude orientation.

Background

In 1975, the Army Research Institute (ARI) sponsored a project to design and develop a map interpretation and terrain analysis course (MITAC) to improve the ability of Army helicopter pilots to navigate accurately when flying at nap-of-the-earth (NOE) altitudes.[1] MITAC was designed to supplement conventional training by increasing the knowledge of aviators on the many rules and conventions that cartographers follow when constructing maps. The instruction included the basis for the selection and classification of roads, coding criteria for vegetation cover, ground rules for delineating relief and drainage, the conventions used for grouping cultural features under standard symbols, the generalization and displacement practices in cartographic drafting, and many other design practices that must be understood if maps are to be interpreted accurately. To supplement the instruction, MITAC provided practical training through cinematic simulation exercises.

In 1978, the course for Army helicopter pilots was modified by the Navy Personnel Research and Development Center for use by the Marine Corps rotary-wing community.[2] MITAC has been well received by the aviation community and is now being used to train Army, Navy, and Marine Corps helicopter pilots.

TRAINING COURSE DEVELOPMENT

Weapons and tactics instructors (WTIs) from Marine Aviation Weapons and Tactics Squadron-One (MAWTS-I), Marine Corps Air Station, Yuma, Arizona were interviewed to identify the requirements of aircrews involved in low-altitude operations and the training

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[1] McGrath, J. J., & Foster, E. A. Development of a system of aircrew training in nap-of-the-earth navigation. Santa Barbara, CA: Anacapa Sciences, Inc., January 1975.

[2] NAVPERSRANDCEN memorandum 306:OAL:11p of 13 Apr 1978 to Headquarters, U.S. Marine Corps (Code APW); subj: USMC air navigation training: interim recommendations for

procedures currently used. Data obtained were used as the baseline for developing the low-altitude orientation training program. This program, which is called MITAC-II to distinguish it from the previous rotary-wing course, consists of an illustrated lecture and dynamic exercises. Both are described below.

Illustrated Lecture

The illustrated lecture is presented in a dual-slide and tape format. The lecture is composed of five sections, beginning with a general introduction and followed by information on four topic areas (topography, hydrography, vegetation, and cultural features). It concludes with a series of static orientation exercises. The entire lecture, including the orientation exercises, runs 4-½ hours.

The lecture is illustrated with 350 real-world scenes (35-mm slides), which were selected from the Boeing Film Imagery Library. The scenes, each of which is matched with a slide of its map portrayal, provide visual examples of the various features discussed in the taped lecture narrations.

Dynamic Exercises

Selection of Mission Films

The 70-mm film imagery used for the dynamic exercises was obtained from the Boeing Film Library. A total of 40 mission films are available, which were developed from imagery obtained during programs supporting Joint Task Force Two (JTF-2) and the Combat Air Support Target Acquisition (Project SEEKVAL) test activities. The purpose of the JTF-2 program, which was a joint-service test and evaluation effort conducted by the Joint Chiefs of Staff between 1965 and 1968, was to evaluate all phases of the low-altitude mission through a combination of field tests, simulation, and analysis/modeling techniques. Simulation imagery developed under this program included filmed routes at 200-, 400-, and 600-foot altitudes, at 1/4- and 1/2-mile offsets in addition to centerline, and filming conditions that allowed a dynamic range of projection playback speeds from 180 to 800 knots.

The SEEKVAL test program, conducted during 1972-74, was administered by the Air Force Test and Evaluation Command (AFTEC). Its purpose was to evaluate target acquisition system concepts using direct or aided vision. For purposes of the current demonstration program, the JTF-2 and SEEKVAL imagery adequately portrayed the flight profile, field-of-view, image quality, color, and dynamic geometry conditions needed to demonstrate feasibility of the MITAC-II program.

Prior to selecting mission films for the dynamic exercises, nominal flight tracks were plotted for each to determine the type of terrain and cultural features contained in the film imagery. Using the course tracks as a guideline, 10 mission films were selected based on the following criteria:

1. Flight altitudes could not exceed 500 feet above ground level (AGL).

2. Filmed flights had to cover a variety of terrain relief while at the same time avoiding flying parallel to roads, transmission lines, etc., over extended distances.

3. The available projection speeds had to be capable of simulating airspeeds from 240 knots to 500 knots.

4. Films had to be of good quality, in terms of brightness, resolution, and image stability.

After the selection was made, two copies of each complete film were printed, spliced, and assembled into mission films. In some cases, not all of the original film was used because of excessive length, lack of significant terrain features, or excessive cultural features. Nominal course plots for each mission film served as a baseline for a more detailed ground-track plotting. Selected films, in the sequence used, are listed in Appendix A.

Videotapes of each mission film were made at 180 knots and at 240 knots. The 240-knot videotapes were used to prepare and time the feedback debrief narrations to be used in the simulator following each dynamic exercise (performance run). During the debrief simulation, the audio channel from these tapes was used to provide a feedback narration played in synchronization with the film. The 180-knot videotapes were used in preparing the debrief narration and as an off-line or out-of-simulator debrief where the participants could stop the tape at any time to examine a feature more closely.

Designation of Mark Points and Turn Points

Mark points (selected features for participant response) and turn points (heading changes) were designated for all flights. Mark point selections were based on relevance to training objectives covered in the illustrated lecture and the visual significance of the mapped features. The number of mark points per mission ranged from 4 to 15, depending on mission length. A brief description of the mark points used in each film is included in Appendix B.

After the mark points had been selected, they were catalogued by frame number relative to the beginning of the mission film. This involved several steps using a 70-mm projector, digital frame counter with memory, and a light table with a frame counter. The frame number for a mark point was selected when the feature was just off the bottom of the frame, representing the nadir or abeam position in the simulator.

Turn points were visually identified while reviewing each film on the wide-screen visual system. They were catalogued using a digital frame counter to record the entering and exiting frame numbers. These frame numbers were used to drive the magnetic heading display. Mission sequence and projection speed/airspeed were agreed upon and detailed ground tracks for all films were plotted.

All mission data were assembled into a notebook by mission film. An example of the format and data is included in Appendix A. Simulation instructions and the response procedures for the simulator portion were developed along with the sequence of events for the feasibility demonstration period.

Preparation of Software and Instructional Materials

When the preliminary design was complete, preparation of software and instructional materials commenced. Programming of mark point and turn point frame numbers, projector speed/airspeed control, instrumentation signals, control signals, and throttle control was completed. Narrations for the preflight briefings and simulation debriefings were written and taped.

Preflight briefing materials used by participants to prepare for each mission included Joint Operations Graphic (JOG) air charts and taped narrations discussing topography, hydrography, vegetation, and cultural features of the flight operations area. The JOG-Air maps (1:250,000 scale) were prepared as mosaics covering the area of interest. The flight track (first three maps) or corridor (last six maps) was marked on the map, as were mark points for selected missions. The maps were laminated with mylar to permit repeated use and to facilitate easy clean-up.

The debriefing materials also included taped narrations and annotated maps. The narrations served to reinforce the orientation principles from the lecture and to provide immediate feedback on orientation performance along the flight track. The maps contained the actual flight track and mark points as well as additional annotated orientation features that were reviewed in the taped narrations.

Simulation Facility

The dynamic exercises were given in the combat aircraft mission simulator at the Boeing Space Center, Kent, Washington. The simulator is an integrated avionics simulation facility composed of several hardware elements with attendant software modules. Various elements and modules are combined, based on mission requirements, to provide the needed crew/cockpit interfaces. The elements used in the course consisted of a multimission simulator lab (MMS) and the Varian 75 computers located in the visual flight simulation lab (VFS) (see Figure 1).

The MMS houses the crew stations, visual display system, and the test instrumentation for conduct of visual flight rules (VFR) and instrument flight rules (IFR) part-task or full-mission simulations. The visual display system, using a wide-angle screen, projects high-resolution cinematography. The wide-angle display encompasses 160 degrees laterally by 60 degrees vertically. The MMS cockpit, which is situated in the center of a 15-foot radius spherical-section screen, is representative of a mid-1980 fighter/attack aircraft and is in a one-place configuration. Cockpit instrumentation was checked and determined to be adequate for the MITAC-II feasibility demonstration.

In the VFR operating mode, imagery from a 70-mm projector recreates the dynamic geometry that would be experienced during actual flight. An arc lamp provides a screen illumination that is nearly the color of daylight and has an open-gate brightness of approximately 20 ft. Lamberts.

A limited number of instruments were activated for the present simulation. These included the airspeed indicator, the altimeter, the radio magnetic indicator, and a digital clock. Control of simulation action was provided by an event switch; and control of airspeed/projector speed for selected exercise films, by a throttle (see Figure 2).

Overall simulation control and data recording were accomplished using the Varian 75 computers, which drove the cockpit instruments and provided the aircraft flight characteristics. The computers also controlled the projector speed/airspeed and cued the tone generator to transmit response stimuli to the participant.

Airspeed was controlled by the computers for seven of the runs. During the two final runs, the participant controlled the airspeed using the throttle. Limits on airspeed in the manual-control mode (500 kts) were dictated by the safe operating limits of the projector and task fidelity.

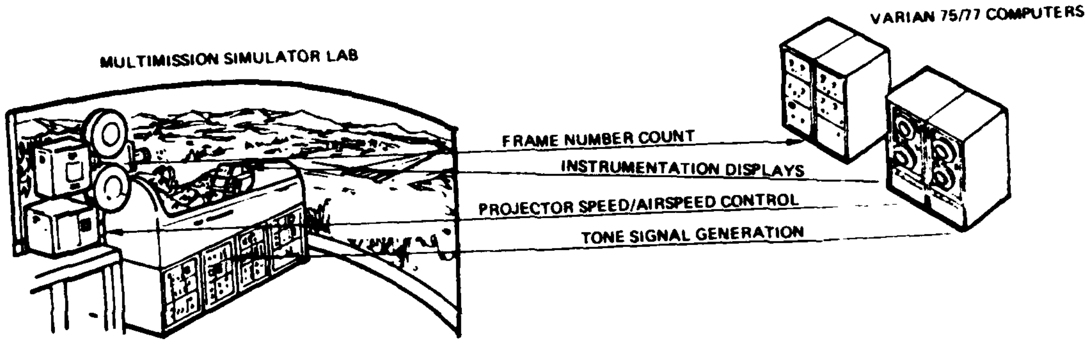


Figure 1. Simulation configuration.

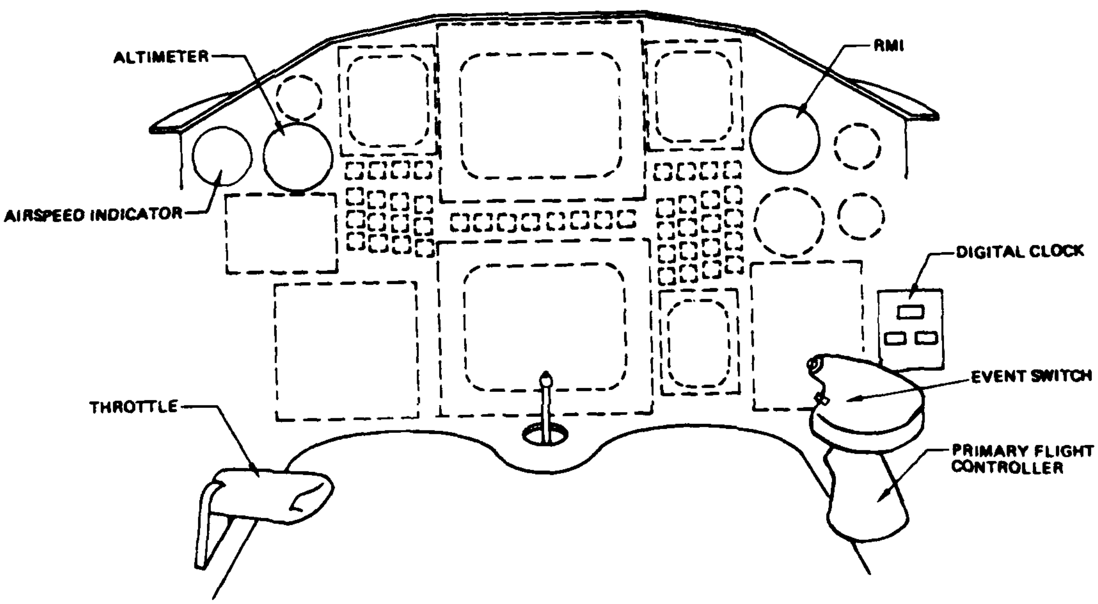


Figure 2. Cockpit configuration for MITAC-II demonstration.

FEASIBILITY DEMONSTRATION

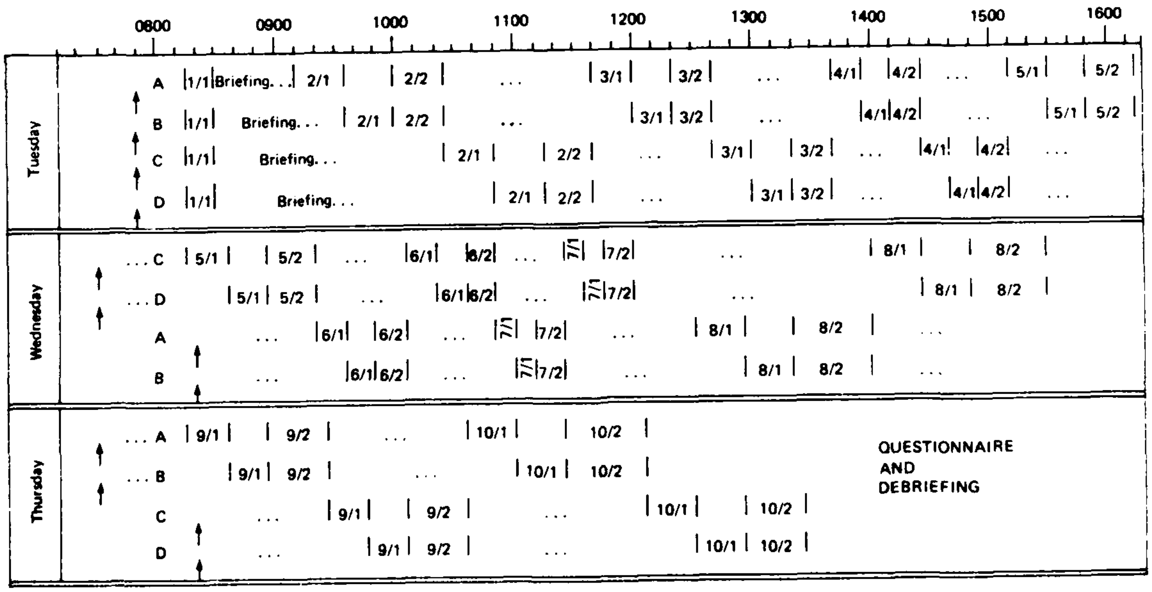
Participants

Fifteen subject matter experts (SMEs) participated in the feasibility demonstration of MITAC-II. Eleven of the participants were WTIs from MAWTS-1, and the other four were advanced crew-training instructors from Fighter Squadron (FITRON) 124, Naval Air Station (NAS), Miramar, San Diego, California. Six of the participants were pilots, six were radar intercept officers, one was an aerial observer, and two were bombardier/navigators. They represented the F-4, RF-4, A-4, A-6, OV-10, and F-14 aircraft communities.

Procedures

Participants reported to the briefing room at the Boeing Space Center in groups of four. After a short introduction, they completed a demographics questionnaire and the first portion of the illustrated lecture questionnaire (Appendices C and D). The 4½-hour illustrated lecture was then presented. As each module of the lecture was completed, it was critiqued by the participants and test personnel. All comments were recorded. Following the lecture, the participants completed the remainder of the illustrated lecture questionnaire.

Participants, in groups of two, were then briefed on the cockpit and simulator, and received instruction on the procedures to be used in the dynamic mission exercises. For the first nine missions, one pair would "fly" and the other pair would brief. These pairs exchanged flying and briefing roles for the subsequent nine missions. As shown in Figure 3, participants flew an initial or performance run individually, and a second or debriefing run together. Each participant, therefore, saw each mission film twice.



Notes: † – Evaluator report-in time
| / | – Numerator is Sequence Number; Denominator is Run Number

Figure 3. Simulation overall run sequence.

A standardized briefing procedure was used for all mission films. Participants spent 5 to 15 minutes studying the track and preparing a flight plan. They then listened to the preflight briefing narration tape for the particular mission. Upon completion of the preflight briefing tape, the participants were given additional time to review their flight plan and to mark changes on the laminated maps using water-soluable marking pens. The briefing time lasted 20 to 40 minutes depending on the length of the mission film. Additional information given the participants included (1) entry-point descriptions, (2) estimated time of arrival (ETA), based on zero time for appearance of first image frame, (3) total length of mission in nautical miles and total estimated time enroute (ETE), (4) airspeed, automatic or manual throttle, (5) nominal altitude above ground level (AGL), and (6) initial heading.

The task and response procedures for performance runs differed, depending on the mission sequence number. As shown in Table A-2, missions 2, 3, and 4 were "along-track" exercises, in which the ground track and mark points were preplotted on the map. When the participant determined he was abeam the mark point, he pressed the event switch on the side-arm controller. The computer then recorded the frame number.

Missions 5, 6, and 7 were "limited-corridor" exercises, using a 4-statute-mile-wide corridor plotted on the briefing maps. Missions 8, 9, and 10 were "corridor" exercises, using 10-statute-mile-wide corridors. The response procedures for sequences 5 through 10 were the same. Approximately 5 seconds before reaching a mark or response point, the participant received a "Ready" tone over his headset. This tone alerted him to prepare to mark his current position on the map. When he heard the next tone, the "Mark" signal, he marked what he determined to be his ground position on the map.

When both "flying" participants had completed their performance runs, they were provided a debrief map that contained the original track or corridor, plus other annotated map features. In the case of the corridor exercises, the ground track and mark points were also plotted on the debrief map. After reviewing the debrief maps, the two participants watched the mission film a second time at 240 knots and listened to the debrief narration played along with the film. When all four participants had completed all of the exercises, they completed the dynamic exercise (simulator) questionnaire.

Evaluation Techniques

The questionnaires served as the primary evaluation measure. Three questionnaires were used: (1) the participant demographics questionnaire, (2) the evaluative questionnaire No. 1--illustrated lecture, and (3) the evaluative questionnaire No. 2--dynamic (simulator) exercises. (Responses to the questionnaires are summarized in Appendices C, D, and E.)

An additional evaluation measure was mark point acquisition error. On mission runs 2, 3, and 4, the event switch was depressed when the participant determined he was over or abeam the preplotted mark point. The computer recorded the frame number and computed a delta from the catalogue frame number for that mark point. The delta was later converted into ground feet (see Appendix B). A correct response, or accuracy criterion, was considered to be within ± 0.5 nm (± 3040 ft) of the catalogued mark point location.

In missions 5 through 10, the evaluative technique compared the participant's mark points from his performance map with the correct responses plotted on the debriefing map. Also, the errors were orally debriefed by a NAVPERSRANDCEN geographer to provide better understanding of perceptional or interpretive problems related to the training objectives.

In the "along-track" exercises (see Appendix B for the objective performance measures), the route and mark points were preplotted on the map. When the participant was over or abeam the mark point, he indicated recognition by activating the response switch that recorded the film frame number. The frame number deltas were converted into ground feet, where frame number delta is defined as the difference between the film frame number corresponding to the map-plotted mark point and the film frame number at which the participant responded. Means and standard deviations were then calculated and plotted. An accuracy criterion of ± 0.5 nm was used. If a participant's response was greater, it was considered a miss and was not included in later calculations. This (as well as a "no" response), resulted in a different number of responses (n) between mark points. The mean distance from the catalogued mark point is plotted by the "X" with one standard deviation represented by the bar. The results were also correlated with response time, which was a function of ground speed. The statistical data indicate that those features having a defined edge or boundary have a smaller standard deviation than those lacking a well defined edge. The majority of responses were made within 2 seconds of the desired response point.

The results from the "limited corridor" and "corridor" exercises were not recorded in this same manner. During the corridor exercises, a tone was sounded that required the participant to mark his aircraft position on the map. These response marks were orally debriefed. No quantitative data were collected on the accuracy of the response.

The primary emphasis in the prototype course was on performance feedback rather than performance evaluation. As such, it relied heavily on knowledge of results and immediate feedback rather than on measures readily amenable to automated data collection.

RESULTS AND DISCUSSION

Participants indicated that MITAC-II was a valuable training tool. (Responses provided in questionnaire summaries and an example of performance data are included in Appendices B, C, D, and E.)

Respondents to the illustrated lecture questionnaire reported that, while the training course would not change their methods of flight planning and visual search, it definitely would make them more aware of the usefulness of topography and better able to convert their map into a three-dimensional terrain picture. Significantly, the content and objectives of the course were fully compatible with the requirements and past experiences of these highly qualified aviators. With only minor exceptions, comments indicated that the presentation of information in the individual lecture modules was acceptable. The participants also suggested that (1) an additional lecture module should be developed to integrate and summarize the information presented in the illustrated lecture, and (2) feature combinations and regional variations should be further emphasized. (It should be noted that the lecture itself was never intended to stand alone but, rather, to be used in concert with the dynamic practice and drill exercises to achieve the desired integration.)

Responses to the simulation exercises questionnaire were also positive. The SMEs felt the performance-run and debrief-run combination was an effective method and that the wide-angle visual system was extremely useful for realistic visual orientation. They suggested that (1) the debrief run, on all missions except those at 240 knots, be shown at the same speed as the performance run, and (2) the coincidence of the "ready" and "mark" tones with the selected response points should be timed more accurately on some features.

The SMEs also commented that, as a map interpretation and terrain analysis course, the system met the objective and, as such, strongly supports navigation techniques for low-altitude operations. However, the distinction between orientation training and navigation training must be clearly made. They also indicated that a wider variety of terrain types should be included in a production course.

New imagery could be procured for the course either by obtaining additional existing Department of Defense (DoD) imagery or by filming new routes, which would allow greater variation in terrain types. Variations might include seasonal changes, shadow/sun problems, and unique mission scenarios such as coastal penetration. New film imagery would offer maximum training benefits, ensuring that film frame rates could be selected for a range of playback speeds to reduce any possible flicker effects. Also, mission profiles, including length, altitude, number, and rate of turns, could be optimized. Films could be tailored to specific training objectives and the illustrated lectures planned around them. Such films, over an extended period, would be cost beneficial.

Changes in equipment and procedures to improve the course were also discussed with participants. For example, it was suggested that screen size could be reduced from the present 15-foot radius spherical-section to a minimum of a 10-foot radius, thus reducing the cost while still maintaining the wrap-around effect. Although other film formats were discussed, it was noted that those having the wrap-around effect and the same or better image quality are not currently available. The primary parameters to consider in film choice are overall film area and aspect ratio. Also, to maintain the 160-degree visual scene, a film aspect ratio in excess of 2:1 is necessary. This constraint applies when linear optical systems, rather than the nonlinear cinemascope, are used. The 70-mm film has approximately this ratio. A double-frame 35-mm format is a possibility but is costly and difficult to handle.

During the feasibility demonstration, the Varian 75 computers controlled the projector speed/airspeed, drove the simulator instrumentation, cued the tone generator, and recorded participants' responses. The participants agreed that full instrumentation was not needed since the "flight" is a "canned" mission. However, the remaining necessary instrumentation and cueing could easily be handled by today's microprocessors.

Because the feasibility demonstration was conducted at a research facility, a large number of personnel was required. In a production course, the illustrated lecture would be tutorial, eliminating the need for support personnel. Once the mission films are assembled and the microprocessor programmed, the dynamic exercises would require only one projector technician.

CONCLUSIONS

Responses indicated that the MITAC-II concept and approach to low-altitude visual orientation training is progressive and advantageous. The format and content of the illustrated lecture were considered informative and were approved by the SMEs. The simulation, using the wide-angle visual system, was effective in providing the necessary environment to integrate the training content with operational tasks. The two components, acquisition of new skills in map interpretation and terrain analysis from the illustrated lecture and use of the simulator to exercise the new skills in real-time, complemented each other well.

RECOMMENDATIONS

1. Improvements are possible in some areas, including refining lecture graphics, offering a wider diversity of terrain type, emphasizing balance within the lecture modules, and improving performance cues and response measures.

2. The event switch that causes the film frame number and plotting mark points to be recorded at each response on the map should be refined for simplified training delivery.

3. The event-switch data could be improved by providing participants with additional response-procedure instructions and familiarization.

4. The mark point plotting technique used with the corridor exercises could be improved by use of a multiple-choice response set on the map.

5. MITAC-II should be evaluated for training effectiveness using aircrew personnel from an operational squadron.

6. The illustrated lecture portion of MITAC-II should be evaluated to determine its training effectiveness as a "stand alone" product.

7. Alternate visual media configurations should be evaluated to determine the most effective training delivery system.

APPENDIX A

SIMULATION SUPPORT DATA

LOW-ALTITUDE NAVIGATION SIMULATION

Mission: Ft. Lewis Track A — Total No. Frames: 9,671

Sequence No.: 7 — Ground feet/frame: 21.3

Total Distance: 33.5 nm

Ground Speed: 360 Kts. = 28.5 frames/second (Performance Run)
240 Kts. = 19.0 frames/second (Debriefing Run)
180 Kts. = 14.25 frames/second (Off-line Debrief)

Performance Run (1): — Page 1 of 3

Frame No.	Event	Action
00000	Project Start	Start computer and projector (28.5 fr/s) A/S, Altimeter, RMI on Initial Heading: 55oT (34oM) Lat: 46o 46' 00"N Long: 123o 04' 00"W Altimeter: 500 ft Airspeed: 360 Kts
(1) 878 (2) 906	"Ready" tones (1st mark point)	Tone generator signals two beeps
1020	"Mark" tone 1st mark point	Tone generator signals one beep
(1) 2983 (2) 3011	"Ready" tones (2nd mark point)	Tone generator signals two beeps
3125	"Mark" tone 2nd mark point	Tone generator signals one beep
(1) 6445 (2) 6473	"Ready" tones (3rd mark point)	Tone generator signals two beeps
6587	"Mark" tone 3rd mark point	Tone generator signals one beep
(1) 9110 (2) 9138	"Ready" tone (4th mark point)	Tone generator signals two beeps
9252	"Mark" tone 4th mark point	Tone generator signals one beep
9671	End of film/run	Projector/Computer off Lat: 47o 04' 30"N Long: 122o 25' 00"W

Figure A-1. Simulation Data Notebook Example

PILOT'S FLIGHT PLAN AND FLIGHT LOG

ARTC FREQ	SEEKVAL TRACK "A"				
	SEQUENCE #7		PERFORMANCE RUN		
AIRCRAFT IDENT		TAKE-OFF TIME	TOTAL DISTANCE	TOTAL ETE	TOTAL AMT FUEL
			33.6	5 + 36	

FIX	ROUTE	IDENT / FREQ	IDENT / FREQ	MAG CRS	DISTANCE / REMAIN	GROUND SPEED	ETE / REMAIN	ETA / ATA	LEG / REMAIN	ACTUAL FUEL REMAIN
	S				0		0	0		
START				034	33.6	360	5+36			
	1				3.6		0+33	0+33		
FWY/RR				034	30.0	360	5+00			
	2				7.4		1+14	1+47		
RD/RR				034	22.6	360	3+46			
	3				12.1		2+01	3+48		
RIVER				034	10.5	360	1+45			
	4				9.3		1+33	5+21		
RD/RR				034	1.2	360	0+12			
	E				1.2		0+12	5+36		
END				034	0	360	0			

AF FORM MAY 66 70 REPLACES AF FORM 21A, JAN 63, WHICH WILL BE USED UNTIL STOCK IS EXHAUSTED.

Figure A-1. (Continued)

Event Summary

Mission: Ft. Lewis Track A

Sequence No: 7 | Page 3 of 3

Start Lat: 46° 46' 00"N
Long: 123° 04' 00"W

End Lat: 47° 04' 30"N
Long: 122° 25' 00"W

Headings (I(H)) 21° Variance

Frame No.	I(H)	Frame No.	I(H)
0000	55T (34M)		
NO TURNS			

Checkpoint NADIR/ABEAM

Frame No.	Ckpt. ID	Frame No.	Ckpt. ID
1. 1020	Bend in I-5 & RR		
2. 3125	Tenino Rd - RR		
3. 6587	River - Powerhouse		
4. 9252	Rd - RR crossover		

Figure A-1. (Concluded)

Table A-1

Mission Characteristics of MITAC-II Simulation Films

SEQUENCE NUMBER	FILM IDENTIFICATION	LOCATION	ALTITUDE, FEET	SPEED RANGE, KNOTS	GROUND COVERAGE NM/FILM FOOTAGE	COMMENTS
1	SEEKVAL D	Ft. Lewis Army Reservation, Washington	500	204 - 362	19.5/490	Broad plains mixed with small forested areas. Flat terrain with evidence of military activity. Many cultural features. Ends over Puget Sound. Initial Latitude: 46°57'15"N Initial Longitude: 122°15'00"NW Final Latitude: 47°06'00"N Final Longitude: 122°40'45"W
2	N-NAV-300 Part I	Arkansas-Oklahoma Border Area	300	288 - 512	78.0/1367	Rolling terrain. Sparsely populated. Ridge lines run east-west. Forested area rather than agricultural. Initial Latitude: 36°16'00"N Initial Longitude: 92°13'15"W Final Latitude: 35°23'30"N Final Longitude: 93°24'00"W
3	N-P-300 Part II	Arkansas-Oklahoma Border Area	300	198 - 352	48.2/1220	Heavy forestation and sparse population. Several rivers. Gently rolling terrain with up to 800 ft elevation differences. Several flat turns in flight. Initial Latitude: 34°40'00"N Initial Longitude: 96°02'00"W Final Latitude: 34°19'30"N Final Longitude: 95°03'30"W

Table A-1
(continued)

SEQUENCE NUMBER	FILM IDENTIFICATION	LOCATION	ALTITUDE, FEET	SPEED RANGE, KNOTS	GROUND COVERAGE NM/FILM FOOTAGE	COMMENTS
4	Hunter-Liggett Demonstration	Hunter-Liggett Military Reservation, California	200	360 - 420	46.8/996	Semi-arid landscape. Sharply rolling terrain with intermittent plateaus. Two towns. Initial Latitude: 35°43'15"N Initial Longitude: 120°43'30"W Final Latitude: 36°10'30"N Final Longitude: 121°08'30"W
5	N-NAV-300 Part II	Arkansas-Oklahoma Border Area	300	288 - 512	86.7/1519	Rolling terrain. Sparsely populated. Ridge lines run east-west. Forested area rather than agricultural. Initial Latitude: 35°23'45"N Initial Longitude: 93°23'30"W Final Latitude: 34°20'30"N Final Longitude: 94°39'30"W
6	N-P-300 Part I	Arkansas-Oklahoma Border Area	300	198 - 352	48.5/1225	Heavy forestation and sparse population. Several rivers. Gently rolling terrain with up to 800 ft elevation differences. Several flat turns in flight. Initial Latitude: 34°23'30"N Initial Longitude: 94°57'45"W Final Latitude: 34°48'30"N Final Longitude: 95°56'30"W

Table A-1
(continued)

SEQUENCE NUMBER	FILM IDENTIFICATION	LOCATION	ALTITUDE, FEET	SPEED RANGE, KNOTS	GROUND COVERAGE NM/FILM FOOTAGE	COMMENTS
7	SEEKVAL A	Ft. Lewis Army Reservation, Washington	500	204 - 362	33.5/736	Flat terrain with evidence of military activity. Mt. Rainier prominent throughout most of flight. Broad plains mixed with small forested areas. Initial Latitude: 46°46'00"N Initial Longitude: 123°04'00"W Final Latitude: 47°04'30"N Final Longitude: 122°25'00"W
8	W-TA-200	Louisiana-Arkansas-Oklahoma	200	288 - 512	145.6/2639	Flight track perpendicular to major ridge lines. 1500 ft elevation difference. More cultural development than some others. One leg of flight parallels ridge lines. Inital Latitude: 34°00'00"N Initial Longitude: 95°38'30"W Final Latitude: 34°22'45"N Final Longitude: 94°28'00"W
9	W-NAV-400	Louisiana-Arkansas-Oklahoma	400	288 - 512	112.0/2639	Broad plains dominated by agriculture and forestry. Flight track crosses numerous roads. Long, straight legs. Terrain very flat. Initial Latitude: 32°29'30"N Initial Longitude: 93°08'30"W Final Latitude: 34°14'00"N Final Longitude: 93°45'30"W

Table A-1

(concluded)

SEQUENCE NUMBER	FILM IDENTIFICATION	LOCATION	ALTITUDE, FEET	SPEED RANGE, KNOTS	GROUND COVERAGE NM/FILM FOOTAGE	COMMENTS
10	E-TA-200	Louisiana-Arkansas-Oklahoma	200	288 - 512	148.9/2659	Flight track perpendicular to ridge lines. 1200 ft elevation difference. Less cultural development than W-TA. Flight ends across large lake. Initial Latitude: 34°01'15"N Initial Longitude: 93°18'00"W Final Latitude: 34°34'30"N Final Longitude: 93°08'15"W

Table A-2

MITAC-II Simulation Exercise Conditions

SEQUENCE NUMBER	FILM IDENTIFICATION	LOCATION	PURPOSE EMPHASIS	PLAYBACK SPEED (KTS) PERFORMANCE	PLAYBACK SPEED (KTS) DEBRIEF	ALTITUDE FEET	THROTTLE CONTROL	MAP FORMAT
1	SEEKVAL D	Ft. Lewis Army Reservation, Washington	Integration of training methods; simulation familiarization	240 - 360	-	500	AUTO	Combination
2	N-NAV-300 Part I	Arkansas-Oklahoma Border Area	Application of terrain analysis module in illustrated lecture	240	240	300	AUTO	Along-Track
3	N-P-300 Part II	Arkansas-Oklahoma Border Area	Increased difficulty; less well defined topographical features	240	240	300	AUTO	Along-Track
4	Hunter-Liggett Demonstration	Hunter-Liggett Military Reservation, California	Cultural; physical features, semi-arid terrain; increased airspeed	360	240	200	AUTO	Along-Track
5	N-NAV-300 Part II	Arkansas-Oklahoma Border Area	Skill: exercise; change to corridor	360	240	300	AUTO	4sm-wide Corridor
6	N-P-300 Part I	Arkansas-Oklahoma Border Area	Force use of more distant terrain, etc. features	360	240	300	AUTO	4sm-wide Corridor

Table A-2

(concluded)

SEQUENCE NUMBER	FILM IDENTIFICATION	LOCATION	PURPOSE EMPHASIS	PLAYBACK SPEED (KTS) PERFORMANCE	DEBRIEF	ALTITUDE FEET	THROTTLE CONTROL	MAP FORMAT
7	SEEKVAL A	Ft. Lewis Army Reservation Washington	Vegetation, hydrography, and cultural features; large contour interval	360	240	500	AUTO	4sm-wide Corridor
8	W-TA-200	Louisiana-Arkansas-Oklahoma	Integration of features; increased airspeed; increased corridor width	480	240	200	AUTO	10sm-wide Corridor
9	W-NAV-400	Louisiana-Arkansas-Oklahoma	Integration of terrain/cultural/time/distance	480 (450 - 500)	240	400	MANUAL	10sm-wide Corridor
10	E-TA-200	Louisiana-Arkansas-Oklahoma	Final integration and review exercise of all training	480 (450 - 500)	240	200	MANUAL	10sm-wide corridor

APPENDIX B

MARK POINT INFORMATION AND ALONG-TRACK EXERCISES RESULTS

This Appendix contains all the mark point descriptions and the results from the Along-Track exercises.

The beginning of the Appendix provides all the information related to the Along-Track exercises. The Tables provide the data of all the participants by mark point. The data are ground-feet deviations from the prebriefed mark point locations. Positive distances indicate late responses by the participants; negative distances indicate early or anticipatory responses. Deviation data were computer-recorded, based on event switch activations by the evaluators. Following each Table is a graphical representation of the results.

The second part of the Appendix provides a listing of the mark points used in the corridor exercises and the approximate distance in nautical miles between them. Designations of these mark points by the participants were made by manually marking the briefing maps upon hearing "mark" signals over the headset. Deviation data as a check for the geographic orientation of the participants were manually recorded by NPRDC personnel during debriefing prior to cleaning the laminated maps for reuse.

Table B-1

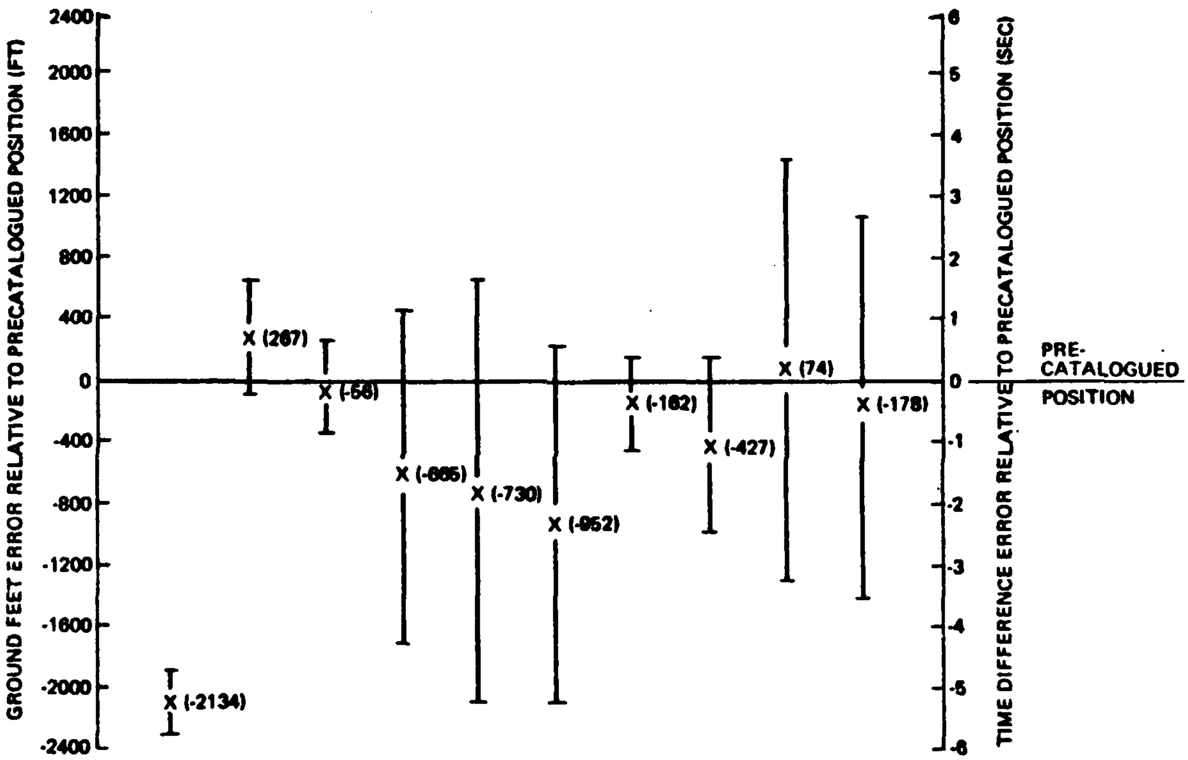
Mark Point Variation -- N-NAV-300 Part I

Mission: N-NAV-300 Part I Speed: 240 kts Altitude: 300 ft AGL

Mark point preplotted on briefing map. Deviation distance in units of feet.

Evaluator Number	Mark Point 01 Shipps Mountain Tower: Deviation Distance	Mark Point 02 Buffalo River (intermittent): Deviation Distance	Mark Point 03 Buffalo River: Deviation Distance	Mark Point 04 Peak east of Marsena: Deviation Distance	Mark Point 05 Hill south of Magic Springs: Deviation Distance	Mark Point 06 Hill north of Raspberry Mtn.: Deviation Distance	Mark Point 07 Lookout tower: Deviation Distance	Mark Point 08 Hill at Big Piney Creek: Deviation Distance	Mark Point 09 Colony Mountain: Deviation Distance	Mark Point 10 Hill north of Piney Bay: Deviation Distance
1	-1682	- 80	80	1201	1816	1068	214	587	*	-3845
2	-2323	614	- 294	-2083	694	1175	374	-1735	- 748	-2029
3	-2189	-5500	- 107	- 961	- 934	-2376	- 240	- 214	561	- 854
4	-1789	267	- 534	- 133	80	- 214	- 133	133	- 721	-1282
5	-2269	507	374	- 854	-1495	0000	- 240	53	2109	- 187
6	-2430	721	- 107	748	-2216	-3351	107	294	15059	160
7	-2323	- 53	5927	- 801	-2670	-2483	- 400	-4646	-6862	881
8	*	*	*	*	*	*	*	*	*	*
9	-2189	294	- 267	9318	*	0000	614	- 454	-2456	267
10	-2296	374	- 320	-2697	-3711	- 988	- 187	- 614	507	3578
11	-2109	3578	-3658	-1922	-2163	- 347	- 240	8464	16687	1095
12	-1949	427	80	- 107	587	-5180	- 267	- 160	1201	- 721
13	-3044	- 641	- 294	- 881	- 908	-1201	- 641	-3898	- 881	-1388
14	-2056	267	187	267	-1629	- 854	- 347	- 320	-4005	2590
15	-2136	507	534	427	80	-2857	- 133	-1095	-1095	- 667
n=	13	12	12	13	12	12	14	11	9	12
x=	-2134	267	- 56	- 665	- 730	- 952	- 162	- 427	74	- 178
=	219	373	315	1114	1383	1165	305	584	1392	1273

* Data lost or no event switch response made by evaluator.



Markpoint No.	1	2	3	4	5	6	7	8	9	10
Descriptor	tower	river	river	peak	hill	hill	tower	hill	mountain	hill
n =	13	12	12	13	12	12	14	11	9	12

Figure B-1. Summary of Mark Point Data -- N-NAV-300, Part I

Table B-2

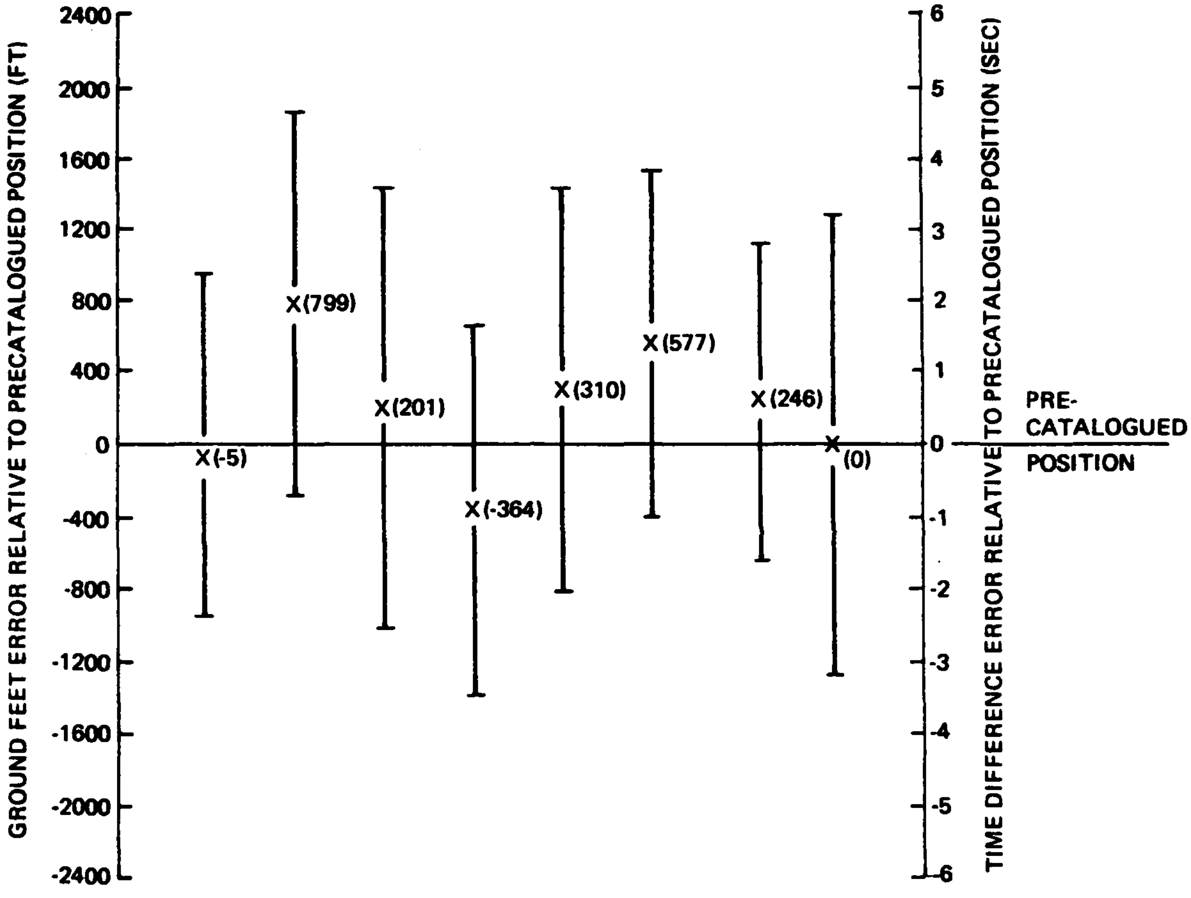
Mark Point Variation -- N-P-300 Part II

Mission: N-P-300 Part II   Speed: 240 kts   Altitude: 300 ft AGL

Mark point preplotted on briefing map. Deviation distance in units of feet.

Evaluator Number	Mark Point	Deviation Distance	Mark Point	Deviation Distance	Mark Point	Deviation Distance	Mark Point	Deviation Distance	Mark Point	Deviation Distance	Mark Point	Deviation Distance	Mark Point	Deviation Distance	Mark Point	Deviation Distance
1	01 Second bridge past pond	592	02 Draw from right	1073	03 Draw before saddle	- 980	04 Dunbar Ridge	- 1276	05 Ridge left of saddle	- 148	06 Ridge to right of course	1517	07 Second spur	- 333	08 Second ridge before peak	7992
2		832		1942		2183		- 74		333		74		370		8750
3		- 1073		814		943		277		2238		8269		3219		*
4		10933		-12617		- 3885		- 9694		- 9527		- 1831		- 370		- 7344
5		*		*		*		*		*		*		*		*
6		- 962		444		- 851		- 1313		3163		14134		6438		*
7		1480		1813		4902		- 814		425		7955		4403		370
8		- 647		- 37		*		1480		- 1443		7215		13301		- 740
9		- 333		- 573		314		- 2072		- 777		1128		- 74		222
10		906		851		- 425		- 74		388		1054		3219		- 2349
11		- 869		- 740		- 647		- 1776		- 166		7037		4736		1961
12		- 1036		- 203		11840		74		388		1054		3219		9934
13		11914		2923		10822		- 203		92		962		851		222
14		*		7696		- 832		- 129		2627		8639		5624		314
15		1054		1276		2109		1165		351		925		1961		-10304
n=		11		12		9		13		12		9		7		7
x=		- 5		799		202		- 364		310		578		246		0
=		980		1097		1265		1058		1132		985		913		1307

* Data lost or no event switch response made by evaluator.



Markpoint No.	1	2	3	4	5	6	7	8
Descriptor	ridge	draw	draw	ridge	ridge	ridge	spur	ridge
n =	11	12	9	13	12	9	7	7

Figure B-2. Summary of Mark Point Data -- N-P-300, Part II

Table B-3

Mark Point Variation -- Hunter-Liggett

Mission: Hunter-Liggett   Speed: 360 kts   Altitude: 200 ft AGL

Mark point preplotted on briefing map. Deviation distance in units of feet.

Evaluator Number	Mark Point 01 Island in Naciemiento Wash: Deviation Distance	Mark Point 02 Harris Creek peninsula: Deviation Distance	Mark Point 03 Hill beyond road-pass: Deviation Distance	Mark Point 04 Jolon Creek: Deviation Distance	Mark Point 05 Unnamed town: Deviation Distance	Mark Point 06 Clearing at Mission Creek: Deviation Distance	Mark Point 07 Draw at Pine Canyon: Deviation Distance
1	-968	-374	-1936	-1100	-2090	-1364	-176
2	22	-286	-7964	-5258	-1210	-2508	-3014
3	-286	-440	-1232	-1628	-66	-286	-2156
4	-682	-110	-308	-4466	-1518	88	-682
5	-220	396	-396	-3190	*	-484	-66
6	-44	1056	154	10120	88	1342	814
7	-638	-660	-2156	-506	*	6864	-2134
8	5192	-110	-792	-110	-5456	11902	7458
9	*	418	-550	352	-6468	-704	-396
10	-176	22	946	8118	-704	-880	-1386
11	-374	-572	-726	8140	-2398	-1364	-484
12	-88	814	-858	-792	-1892	-176	-418
13	-308	-198	-484	198	-506	1210	-638
14	-352	-220	-374	-4598	-770	-1012	-264
15	66	132	-1144	462	-2684	-154	66
n=	13	15	14	8	11	13	14
x=	-311	-9	-839	-390	-1250	-484	-781
=	300	494	626	748	940	1037	1033

* Data lost or no event switch response made by evaluator.

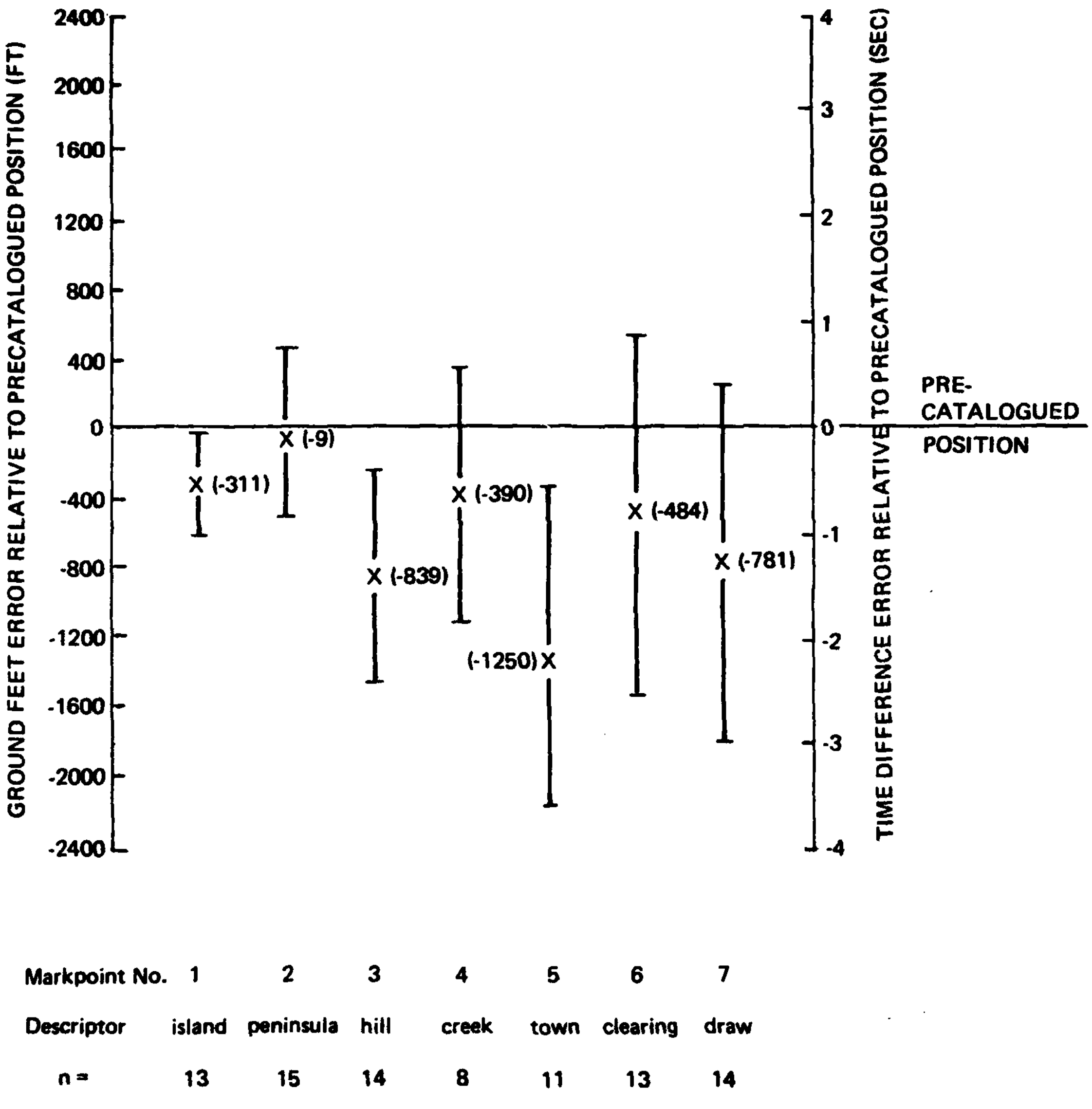


Figure B-3. Summary of Mark Point Data – Hunter-Liggett

Table B-4
Mark Point Description -- N-NAV-300, Part II

Mission: N-NAV-300 Part II   Speed: 360 kts   Altitude: 300 ft
Mark points plotted inflight by evaluator responding to audio signal

MARK POINT NUMBER	IDENTIFIER	POINT-TO-POINT DISTANCE (nm)
1	Rich Mountain	(Start) 14.0
2	Dry Creek Mountain intermittent stream	16.4
3	Highway 80 Ridge	9.6
4	Peak 1383 ft	8.0
5	Peak near Fourche Mountain	10.5
6	Peak southeast of Round Mountain	11.9
7	Primary and secondary streams confluence	6.7
8	Ridge before tower	8.3

Table B-5
Mark Point Description -- N-P-300, Part I

Mission: N-P-300 Part I   Speed: 360 kts   Altitude: 300 ft
Mark points plotted inflight by evaluator responding to audio signal

MARK POINT NUMBER	IDENTIFIER	POINT-TO-POINT DISTANCE (nm)
1	1400 ft peak on right	(Start) 3.9
2	Transmission line crossing ridge	2.9
3	Nashoba spur	5.1
4	Highway 271 spur	4.8
5	1350 ft spur	5.5
6	Third ridge	3.5
7	Spur southeast of peak 1450 ft	4.6
8	Highway 43 hill	5.8
9	South peak	6.8
10	Perpendicular ridge	5.1

Table B-6
Mark Point Description -- SEEKVAL A

Mission: SEEKVAL A Speed: 360 kts Altitude: 500 ft
Mark points plotted inflight by evaluator responding to audio signal

MARK POINT NUMBER	IDENTIFIER	POINT-TO-POINT DISTANCE (nm)
1	Bend in I-5 and railroad	(Start) 3.6
2	Tenino Road - Railroad	7.4
3	River - Powerhouse	12.1
4	Road - railroad crossover	9.3

Table B-7
Mark Point Description -- W-TA-200

Mission: W-TA-200 Speed: 480 kts Altitude: 200 ft
Mark points plotted inflight by evaluator responding to audio signal

MARK POINT NUMBER	IDENTIFIER	POINT-TO-POINT DISTANCE (nm)
1	Shallow saddle	(Start) 13.3
2	Albert, third ridge	7.1
3	Big Fork Ridge at road bend	10.1
4	2443 ft peak	13.1
5	Ross Mountain	8.5
6	Saddle east of East Poteau Mountain	7.5
7	970 ft hill	6.7
8	Midland Dam	10.1
9	Railroad - road	12.2
10	Dog Creek Spur	9.5
11	Lake Wister Dam	11.4
12	River - railroad	10.2
13	Highway 259 ridge	5.3
14	Blue Bouncer Mountain	8.5
15	1100 ft hill	12.0

Table B-8

Mark Point Description -- W-NAV-400

Mission: W-NAV-400 Speed: 480 kts Altitude: 400 ft

Mark points plotted inflight by evaluator responding to audio signal

MARK POINT NUMBER	IDENTIFIER	POINT-TO-POINT DISTANCE (nm)
1	Dual Highway 20	(Start) 5.0
2	Transmission line - Highway 79 crossing	6.9
3	Leton (town)	10.7
4	Transmission line - road east of Rocky Mountain	18.2
5	Road - railroad near Lumber	12.0
6	Transmission line - north of Bethel	4.9
7	Tower - hill 525 ft	12.0
8	Road - railroad northeast of Emmett	8.2
9	Railroad bend near Ozan Creek	11.7
10	500 ft hill	9.6
11	Peninsula before Daisy Bridge	10.8

Table B-9

Mark Point Description -- E-TA-200

Mission: E-TA-200 Speed: 480 kts Altitude: 200 ft

Mark points plotted inflight by evaluator responding to audio signal

MARK POINT NUMBER	IDENTIFIER	POINT-TO-POINT DISTANCE (nm)
1	Ridge past Twin Bridges	(Start) 13.7
2	Highway 70 hill	10.6
3	Gaston hill	14.3
4	Fourche Mountain	10.1
5	Parks (town)	9.9
6	Pilot Knob hill	11.1
7	810 ft hill	7.1
8	Blue Mountain Lake Dam	9.6
9	Potts Ridge	7.6
10	Hogan Mountain draw	9.0
11	1090 ft ridge	11.4
12	1660 ft spur	8.9
13	Lake Spur	8.8
14	Peak at cove	10.5
15	Saddle at end of film	6.3

APPENDIX C

PARTICIPANT DEMOGRAPHICS SUMMARY

MITAC-II DEMONSTRATION EXERCISE

PARTICIPANT DEMOGRAPHICS

Date ______________

Name and Rank ____________________

Duty Phone ______________

1. Please list your flight experience (both military and private) in terms of hours by aircraft type and position:

	Position			
Aircraft Type	Pilot	RIO	BN	AO
F-4	70-1900	1200-2100		
RF-4B		850		
F-14	850-950	270-275		
A-4	400-2300			
A-6			1100-1700	
OV-10				

2. Please list all Navigation training courses you have received:

Date	Course Title	Primary Objective	Classroom Hours	Flight Hours	Low-Level Emphasis (Yes,No)
	Basic Jet Navigation	Training	2-50	5-35	No
	Low-Level Navigation	Training	2-25	3-18	Yes
	Low-Level Tactics	Instructor-Training	4-8	10-20	Yes
	TARPS	Low-Level Recce	20-39	11-20	Yes

3. Please list your low-level (terrain flight) experience. Indicate combat (C) or training (T).

Altitude: Min - 200-ft 2-200 hrs C,T 200 - 500-ft 20-400 hrs C,T

Airspeed:	less than 360 Kts	0-2000 hrs	C,T
	360 - 480 Kts	0-300 hrs	C,T
	480 - 540 Kts	0-125 hrs	C,T
	more than 540 Kts	0-25 hrs	C,T
Sortie length:	less than 75 nmi	0-1500 hrs	C,T
	75 - 150 nmi	0-150 hrs	C,T
	150 - 250 nmi	0-500 hrs	C,T
	more than 250 nmi	0-200 hrs	C,T

4 Considering your overall low-level experience as 100%, how would you apportion that to experience with the following types of terrain:

a) Desert 10-80

b) Forest 5-30

c) Mountains 1-40

d) Hills 2-25

e) Plains 1-20

f) Urban areas 1-5

g) Rural areas 3-95

5. What proportion of your low-level experience is in:

VMC daytime 70-100

VMC nighttime 1-20

IMC daytime 1-10

IMC nighttime 5-10

6. What maps are you most familiar with for

a) Mission planning? 1:250,000 and 1:500,000

b) Inflight reference? 1:250,000 and 1:500,000

7. Which maps do you like best for

a) Mission planning? 1:250,000

b) Inflight reference? 1:500,000

8. Please list other Nav-Aids, materials and/or devices which you have found to be useful for low-level navigation and flight planning (e.g., photomaps, recce photography, sensor imagery, etc.).

Photos, photomaps, sensor imagery, and INS

APPENDIX D

ILLUSTRATED LECTURE QUESTIONNAIRE SUMMARY

MITAC-II DEMONSTRATION EXERCISE
EVALUATIVE QUESTIONNAIRE NO. 1
(Illustrated Lecture)

Date ________________

Name and Rank ______________________________ Duty Phone (Commercial) ______

The questions below are designed to give us information on how you view the usefulness of the illustrated lecture format and content relative to fixed-wing aircraft, low-level navigation training. There obviously are no right or wrong answers, but the thoughtfulness of your answers will have a significant influence on how we can improve our map interpretation and terrain analysis training. All questions should be answered relative to your experience with operational requirements.

PRELECTURE

Please rank order the importance of the cartographic features shown below in meeting low-altitude navigation requirements as you currently view them.

(1 - most important, 4 = least important)

Topography and terrain analysis	1
Vegetation patterns	4
Hydrography	2
Cultural features	3

Comments:

o Ranking will vary depending on type of terrain and mission scenario.

o Hydrography and vegetation patterns somewhat related; their importance changes with location and season.

o Vertical development probably best feature available

1. Please rate the components of the illustrated lecture by filling out the matrix. For example, if you think the pictorial examples of vegetation patterns were fairly representative of what you would expect to encounter during actual flight operations, write "3" in the corresponding row and column of the matrix.

	TOPOGRAPHY & TERRAIN ANALYSIS	VEGETATION PATTERNS	HYDROGRAPHY	CULTURAL FEATURES
Verbal Description	4	4	4	4
Pictorial Examples	4	4	4	4
Cartographic Examples	4	4	4	4

Perfect = 5
Good = 4
Fair = 3
Adequate = 2
Poor = 1

2. Was the verbal description for the corresponding lecture section: (Y = Yes, N = No)

	YES	NO	SOMETIMES
a. easily understandable?	15	0	0
b. too long?	1	11	3
c. too short?	1	13	1
d. too general?	0	14	1
e. too detailed?	1	13	1
f. too much oriented towards cartographers' jargon or concern?	1	13	1
g. adequately concerned with matters beneficial to your flight environment?	12	1	2
h. informative relative to overall navigation training requirements?	15	0	0

Comments:

o Presentation very good

o Need to discuss relationships among individual features

o Correlation of all terrains and each aspect of a particular environment need to be emphasized

o Need to draw all four segments together in a summary of low-altitude navigation

3. What, if anything, bothered you about the pictorial examples used (e.g., field of view, range to feature, representativeness of example, etc.)?

- o Field of view too narrow
- o Map picture should be oriented the same and contain the same ground coverage as the pictorial example
- o Altitude and range to feature needed

4. What, if anything, bothered you about the cartographic examples used (e.g., map scale, shading, features portrayed, etc.)?

- o Map overlap sometimes bothersome due to shading road portrayal, etc., differences
- o Vegetation segment could use more emphasis
- o Some of the general statements may be valid for some regions but not others

5. Prior to the lecture, you rank-ordered the importance of cartographic features for your low-altitude navigation requirements. Did that rank order change in your view based upon the illustrated lecture?

No change for majority of evaluators (Yes - 5, No - 10)

If so, please provide new rank order (1 = most important, 4 = least important)

Topography and terrain analysis	1
Vegetation patterns	4
Hydrography	2
Cultural features	3

6. Please describe how the illustrated lecture will influence your flight planning.

- o Will pay more attention to topography and vegetation
- o Will certainly aid in converting a map into a three-dimensional picture
- o Very little. Information will backup methods already used

7. How do you think the illustrated lecture will affect your visual search, that is what you will look for and how you plan to find it, during actual and simulated navigation training flights?

- o It probably will not affect the visual search
- o Greater emphasis on topography

8. Do you think your navigation procedures (flight planning, visual search, frequency of orientation checkpoints, etc.) will change as a function of the following? If so, how?

   a. Aircraft speed? Yes, choose fewer, more distinct checkpoints

   b. Altitude? Yes, planform versus obliquely significant checkpoints

   c. Other inflight tasks? Yes, as the tasking increases, the checkpoints must be more distinct

9. Any other comments that you might want us to consider for map interpretation and analysis training?

   - A module specifically on maps (i.e., symbols used, indexes, etc.)

   - Use of more graphics to illustrate a point

   - Terrain analysis is quite different at 200 kts as compared to 480 kts Subtle terrain changes are not noticed

   - Might consider actual flight planning with slides

10. The next items are in the form of an opinion questionnaire. Consideration is given to the MAP INTERPRETATION section and the CONTOUR INTERPRETATION section of the illustrated lecture. Please place a check-mark by the statement which corresponds with your opinion or write a short statement expressing your opinion.

MAP INTERPRETATION SECTION

Format
14 ( ) Retain dual screen
( ) Prefer single screen
1 ( ) Prefer split screen (small insets)
( ) Other: ______

Narrations
12 ( ) Retain present pace
( ) Increase pace
1 ( ) Decrease pace
2 ( ) Other: Some areas need a slower pace, others faster

Narrations
15 ( ) Audio Quality Adequate
( ) Audio Quality Inadequate
( ) Other: ______

Content-Scope
9 ( ) Retain present scope
6 ( ) Expand scope
( ) Reduce scope
( ) Other: Include JOG AIR discussion anc final lecture on tactics; add airfields

Content - Level of Detail
13 ( ) Retain present detail
2 ( ) Increase detail
( ) Reduce detail
( ) Other: ______

Content - Map Examples
4 ( ) Retain present examples
11 ( ) Improve examples
( ) Reduce examples
( ) Other: Use same map edition; more varied terrain; displayed area on map ansd slide to coincide

Content - Terrain Type Examples (Pictorial)
9 ( ) Retain present examples
6 ( ) Expand examples
( ) Reduce examples
( ) Other: Need more varied terrain; improve some faded photos

CONTOUR INTERPRETATION SECTION

Format
14 ( ) Retain dual screen
( ) Prefer single screen
1 ( ) Prefer split screen (small insets)
( ) Other: ______

Narration
13 ( ) Retain present pace
( ) Increase pace
2 ( ) Decrease pace
( ) Other: ______

Narration
15 ( ) Audio Quality Adequate
( ) Audio Quality Inadequate
( ) Other: ______

Content - Scope
14 ( ) Retain present scope
1 ( ) Expand scope
( ) Reduce scope
( ) Other: ______

Content - Level of Detail
14 ( ) Retain present detail
( ) Increase detail
1 ( ) Reduce detail
( ) Other: ______

Content - Map Examples
11 ( ) Retain present examples
3 ( ) Improve examples
( ) Reduce examples
1 ( ) Other: Enlarge examples

Content - Terrain Type Examples (Pictorial)
12 ( ) Retain present examples
3 ( ) Expand examples
( ) Reduce examples
( ) Other: Need larger field of view; more varied terrain types

Content - Graphics Examples
7 ( ) Retain present examples
5 ( ) Improve present examples
1 ( ) Reduce examples
( ) Other: Need more varied terrain types

Content - Relevance of Examples
10 ( ) Retain present examples
2 ( ) Improve present examples
3 ( ) Other: Correlate the areas and combine features

APPENDIX E

SIMULATOR EXERCISES QUESTIONNAIRE SUMMARY

MITAC-II DEMONSTRATION EXERCISE
EVALUATIVE QUESTIONNAIRE NO. 2
(Simulator Exercises)

Date ______________

Name and Rank ______________________________ Duty Phone (Commercial) _____

1. Were the materials provided for flight planning sufficient for meeting inflight task requirements?
Yes - 11, No - 3

If not, what is needed?

- o Charts in some cases were too cumbersome
- o Ability to plot headings on map - need variation
- o Dividers, compass rose

2. Did you have sufficient time to prepare for each flight?
Yes - 15, No - 0

3. Did your approach to flight planning change as we went from "along track" to "corridor" maps? If so, how?
Yes - 13, No - 1

- o Time hacks less important and more general
- o Had to be aware of much larger area
- o Used topographical features more and cultural features less

4. Did the two different corridor widths have a differential effect on your flight planning? If so, how?
Yes - 3, No - 12

- o Had to review more area
- o Altitude more critical as pertaining to field of view

5. How do you rate the following aspects of the simulation flights: (Please circle one number per item)
(Circled answers represent the highest frequency response by the evaluators.)

	Excellent				Poor
Visual Scene (Films)	5	4	3	2	1
Active Cockpit Displays	5	4	3	2	1
Cockpit Lighting	5	4	3	2	1
Event Switch	5	4	3	2	1
Throttle Control	5	4	3	2	1
Screen Brightness	5	4	3	2	1
Image Sharpness	5	4	3	2	1

6. How useful were the following for maintaining geographic orientation?
(Circled answers represent the highest frquency response by the evaluators.)

	Extremely Useful				Not Useful
RMI	5	4	3	2	1
Airspeed Indicator	5	4	3	2	1
Clock	5	4	3	2	1
Detailed Track Plots	5	4	3	2	1
Four-mile Corridor Plots	5	4	3	2	1
Ten-Mile Corridor Plots	5	4	3	2	1
Topographic Features	5	4	3	2	1
Vegetation Patterns	5	4	3	2	1
Hydrographic Features	5	4	3	2	1
Cultural Features	5	4	3	2	1

7. Did you experience any differences in your ability to maintain geographic orientation as the flight speed increased between sets of flights?
Yes - 8, No - 7

o Specific features were difficult to see, hard to find some markpoints

o Higher speeds more comfortable

o Made no difference

8. Were the debriefing runs on the simulator helpful for gaining a better understanding of map interpretation and terrain analysis?
Yes - 15, No - 0

   o Especially with the light pointer

   o Allowed one more chance to view terrain and reinforce patterns or correct misconceptions. Use same speed on debrief as on performance run

9. Were the checkpoints and "mark points" similar to those you would use in operational situations"

   a) Before these exercises?
   Yes - 1, No - 11, Maybe - 1

      o At high speeds, only very significant features are used as checkpoints

   b) As a result of these exercises?
   Yes - 0, No - 9, Maybe - 4

      o It will not change planning, but will increase awareness and knowledge of such features

10. Considering training objectives, how beneficial do you think the extremely wide field-of-view of the Boeing simulator is for acquiring navigation skills?

   o Wide screen allowed very accurate presentation of actual low-level navigation - very valuable

   o Great except for blurring on periphery

   o Extremely useful

11. For the items listed below, please check or write in your recommendation or opinion.

Along-Track Performance Exercises

10 ( ) Retain present format and number of exercises
3 ( ) Expand number of exercises
( ) Reduce number of exercises
2 ( ) Other: Increase variety of terrain; maybe change order of films

Along-Track Debrief Exercises (Simulator)

8 ( ) Retain present format
1 ( ) Improve narrative content
1 ( ) Improve narrative cueing
1 ( ) Improve narrative content and cueing
( ) Delete simulator debrief
4 ( ) Other: Debrief at airspeed flown; use the light arrow

Limited-Corridor Performance Exercises

12 ( ) Retain present format and number of exercises
1 ( ) Expand number of exercises
( ) Reduce number of exercises
2 ( ) Other: Expand corridor width to 5 - 10nm; increase variety of terrain

Limited-Corridor Debrief Exercises (Simulator)

9 ( ) Retain present format
( ) Improve narrative content
1 ( ) Improve narrative cueing
1 ( ) Improve narrative content and cueing
( ) Delete simulator debrief
4 ( ) Other: Debrief at same speed as performance run; use light arrow

Corridor Performance Exercises

11 ( ) Retain present format and number of exercises
2 ( ) Expand number of exercises
1 ( ) Reduce number of exercises
1 ( ) Other: W-NAV-400 could be omitted or reduced in length

Corridor Debrief Exercises

7 ( ) Retain present format
2 ( ) Improve narrative content
( ) Improve narrative cueing
2 ( ) Improve narrative content and cueing
( ) Delete simulator debrief
4 ( ) Other: Debrief at performance speed; use light arrow

Pre-Flight-Mission Planning Materials were:

12 ( ) Satisfactory
( ) Unsatisfactory (Specify): Order - Precise low-altitude navigation key
( ) Other: Consider not using laminated charts; preflight tape needs to walk through mission rather than discussing each individual major topic

Post-Flight-Debrief Materials were:

15 ( ) Satisfactory
( ) Unsatisfactory (Specify): ____________
( ) Other: ____________

Audio Cueing of Mark Points was:

14 ( ) Satisfactory
( ) Unsatisfactory (Specify): ____________
1 ( ) Other: Some were slightly off

References to Feature Positions were:

12 ( ) Satisfactory
( ) Unsatisfactory (Specify): ____________
3 ( ) Other: Difficult to see certain features such as multiple ridges, spurs, and draws. A visual reference on film would be helpful.

Position Reference Should be Provided:

4 ( ) E-W/N-S
6 ( ) Left-Right/Up-Down
5 ( ) Other: Clock codes; distance; left or right of track; light pointer

The total number of exercises for Initial Terrain Flight Training is:

10 ( ) Satisfactory
4 ( ) Should be increased
1 ( ) Should be decreased
( ) Other: Perhaps one "lost" exercise; desert operations; reduce distractors initially, then add on more later

The variety of Terrain for Initial Terrain Flight Training is:

6 ( ) Satisfactory
8 ( ) Should be increased
( ) Should be decreased
2 ( ) Other: Desert, high mountains; jungle, snow could be added

Emphasis should be on:

13 ( ) Performance feedback
1 ( ) Performance evaluation
1 ( ) Other

- Leave evaluation to 101/102 etc.
- Increasing our recognition ability - map interpretation, reading the JOGs properly and relating to the actual terrain. JOG AIR emphasis vice TPC maps.
- Both feedback and evaluation.

Where does this program fit in USMC Training?

5 ( ) Training Command
6 ( ) Replacement Air Group
3 ( ) Unit Level

- A good start point would be to introduce this at the training command level to give them a better understanding of map interpretation.

- Need to get some flight time and experience under your belt first.

- Course needs to be precisely defined. It is currently designed as Map Interpretation and Terrain Analysis Course. It performs this objective beautifully. It is not a navigation training course. It does not talk about tactics nor are the checkpoints those which would normally be used. This should be emphasized. Generally the course was excellent. It demonstrates a very definite requirement to be able to determine position using topography primarily at a minimum. Would like to see entire slide program and at least a 16mm capability of some sort hit the fleet.

- Also reviewed in unit level. Enjoyed the program. My learning curve was remarkable (for me!). The program as is teaches map interpretation and terrain analysis better than any method I can think of, it does not however teach navigation in high-speed low-altitude flight and it must be carefully differentiated. It nevertheless is extremely valuable. The cockpit simulation was good, however the instrumentation (excepting the clock) is needless because there is no task associated with them. Improvements needed: better film quality, varying terrain, and refinement of lecture material.

  Additionally, the entire program should be reviewed to purge any contradictory statements with good navigational techniques (e.g., program states that a tower is not a good feature to confirm your position because of numerous unmapped towers. True enough! But wrong if you consider flying a course (HdG) for 3 minutes at a given airspeed and at 3 minutes you should be over a tower, then you've got a good confirmation of position!)

  Program also needs a segment at the end of the lecture which ties together topography, vegetation, hydrography, and cultural features. The lectures treat them separately which is fine, but you need to pull them all together to show their interaction and play!

  I feel that a definite division has to be made between high-speed low-level map interpretation and terrain analysis and high-speed low-altitude navigation.

- The slide/sound presentations are very adaptable to training command and unit level.

- Fly debrief before mission without designation mark points.

- Also unit level. Periphery of film imagery blurred - need better resolution. Need to add throttle control to adjust a/s to the minimum available (within safe limits of projector) for instructional purposes. Also, it allows the student to readjust his a/s to get back on track time-wise. Differences of map and film must be brought out prior to run, (e.g., tell us if a major highway was not built when film was shot even though it shows on the map). Need to expand course material to cover in more detail how to reorient yourself if you got off track.

- Also unit level. Cockpit light on acetate is a problem. Maps should contain color tint/declination and other marginal information.

- Also RAG

- Training is universally common to various USN missions at training command level (i.e., attack, recce, photo escort). Trainees can all be trained in detailed chart analysis at a single point. At RAG level, specific mission tasks should receive higher concentration with chart analysis being understood.

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